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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/819,343	03/28/2001	Calvin T. Gabriel	39153/298 (F0785)	4248

7590

08/27/2002

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EXAMINER

SAGAR, KRIPA

ART UNIT	PAPER NUMBER
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1756

7

DATE MAILED: 08/27/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/819,343

Applicant(s)

GABRIEL ET AL.

Examiner

Kripa Sagar

Art Unit

1756

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 28 March 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-24 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-24 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 7/30/01 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Information Disclosure Statement

1. The information disclosure statement filed on 7/30/01 has been placed in the application file, and the information referred to therein has been considered as to the merits. However certain cited references have been crossed-off on form PTO 1449 because they refer to unpublished patent applications. This will prevent the application numbers of unpublished applications from being printed in the event of a patent publication resulting from this application.

Specification

2. The disclosure is objected to because of the following informalities: The blank spaces in Cross References to Related Applications must be filled in with the appropriate US application numbers.

Appropriate correction is required.

Claim Rejections

3. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and, *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

4. Claims 1,9,16 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1,9,16 of co-pending Application No. 09819342 ('342 reference) in view of US Pat. 5876903 to Ng et al. Although the conflicting claims are not identical, they are not patentably distinct from each other because of the reasons outlined below.

The instant invention discloses a method of trimming a resist pattern by modifying the patterned resist feature in an ion dominated environment.

The instant claims disclose: modifying the top of the resist pattern in an ion dominated environment that renders the modified portion of the patterned feature more resistant to an etching operation than the lower portion; and using the difference in the etch rates to trim (the lateral dimensions of) the feature. Application to the fabrication of an integrated circuit with sub-lithographic dimensioned features is disclosed.

The '342 application is directed towards a method of trimming a feature patterned on a photoresist after modifying the patterned resist feature with electron irradiation.

The cited reference claims : modifying the top of the resist pattern, that renders the top portion of the patterned feature more resistant to an etching operation than the lower portion; and using the difference in the etch rates to trim (the lateral dimensions of) the feature. The technique is used to fabricate integrated circuits with sub-lithographic dimensioned features.

The '342 reference does not teach the use of ion beams to harden the resist features.

Ng teaches that the surface layer of a patterned resist feature may be hardened by ion bombardment, which results in a virtual hard mask (2;28-36). The ion beam is directed towards the top as well as the sidewalls to harden all the exposed surfaces equally and create a uniform hardened layer (4;39-61). This reduces the etching rate of the sides more than the top which is the intended goal of the invention (4;62-5;19). However selective hardening of the top of the feature by a directed beam is known in the art.

It would have been obvious to one of ordinary skill in the art to modify the top of the patterned resist feature by ion bombardment as taught by Ng and thereby induce a difference in the relative etch rates of the modified and un-modified portions of the patterned resist feature. The difference in etch rates would be used to trim the patterns as taught in the '342 reference.

Claim Rejections - 35 USC § 112

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claims 9-15 and 19 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 9,13 and 14 recite the limitation " the ashing step " in lines 13, 23 and 26 respectively. There is insufficient antecedent basis for this limitation in the claim.

While resist trimming may be performed by ashing this is not defined in any of the steps and makes the claims vague and indefinite. This rejection may be overcome by rephrasing claim 9 to recite "an ashing step" in line 13 . Claims 10-12 and 15 depend directly or indirectly from claim 9.

Claim 19 recites the limitation that "top portion has a negligible etch rate". The term "negligible" is a relative term not well defined and makes the claim vague and indefinite. The specification discloses etch rates that are 15% - 70% slower than untreated resist as being negligible (p.10; #0036) and another measure suggests 10% - 50% loss of vertical height (p.13;#0044) as being negligible.

Claim Rejections - 35 USC § 103

7. Claim 1-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Pat. 5962195 to Yen et al. in view of US Pat.6200903 to Oh et al. and further in view of US Pat. 4394211 to Uchiyama et al.

The invention is directed towards a process for trimming resist patterns.

The claims disclose a process for trimming a resist pattern by (a) modifying the top portion of the pattern in an ion-dominated environment causing the modified portion to have an etch rate different from the unmodified portions of the pattern and (b) trimming the pattern so that the lateral etch rate is greater than the vertical etch rate. (c) removing the resist.

Yen teaches a method of trimming a resist pattern to form a trimmed gate on an FET. Control of line widths is critical to the process. A resist layer (22) is formed on an (ARC) anti-reflective coating (20) formed over a gate stack (Fig.1). The resist is patterned with a width W_1 larger than the intended gate width. The resist feature is plasma hardened (Fig.3) by a "plasma pretreatment" (9;10-10;5). The pre-treatment exposes the resist to a flood of ions comprising Ar^+ and F^+ ions. The hardened resist pattern and the ARC are plasma etched. The lateral etch rate is greater than the vertical etch rate (10;6-35); as a result the pattern width is reduced to W_2 (Fig.4). This pattern is transferred to the gate layer by anisotropic etching to preserve the reduced gate width and pattern height integrity (Figs.5-6). The resist and ARC are removed (Fig.7). Yen patterns features with near UV (365nm) radiation to form sub-lithographic dimensioned gates. Etch bias of 145 nm is reported (16;5-14)

Yen does not teach modifying the trim rate with the dose of the ions (cl.4) or the energy and mass of the ions (cl.5,15). It does not teach implanting Ar^+ , F^+ or Kr^+ ions (cl.17,20,21). Yen does not teach patterning 150nm features using deep UV radiation or removing the top of the resist before etching the substrate (cl.22-23).

Oh teaches Ar⁺ implantation into patterned resist features to reduce the etch rate. The resist pattern is formed on a substrate to be etched (Fig.5). The patterned features are irradiated with Ar⁺ ions (fig.6). The implantation parameters include the angle, dose and depth (3;24-53). Oh teaches that the resist is significantly etched in the vertical dimension (cl.22) during transfer of pattern to the substrate (Fig.7 & 4;1-17).

Oh does not teach modifying the etch rate with the dose. It does not teach patterning 150nm features using deep UV radiation

Uchiyama teaches hardening a polyimide resin layer by ion bombardment to minimize etchant attack. The etch rate is dependent on the dosage (Fig.1). The etch rate may be varied by the mass and energy of the ion (3;10-18). It is well known in the art to adjust the depth by controlling the energy of the ion.

Uchiyama does not teach patterning 150nm features using deep UV radiation.

However deep UV patterning and fine pitch geometries are well known in the art and unique to a particular application .

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use ion implantation as taught by Oh in controlled doses and depths as taught by Uchiyama to form etch resistant features for laterally trimming Yen's gates because Oh teaches that the ion hardening process permits the use of thinner resist layers with increased yields and fewer defects (5;4-14) and Uchiyama teaches that by controlling the ion implantation parameters one can precisely modify the etching characteristics of any polymer to a desired level (1;64-2;16) and thereby reduce the defect rate (4;35-55).

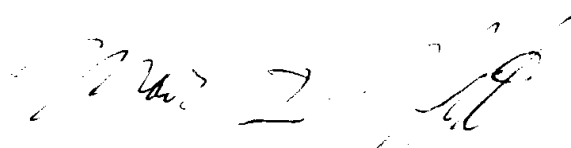
Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kripa Sagar whose telephone number is 703-605-4427. The examiner can normally be reached on 8:00AM--5:00PM (M-F).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark F Huff can be reached on 703-308-2464. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

MH/ks
August 22, 2002


MARK F. HUFF
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700